FUTURE WATER QUALITY ISSUES IN THE PRAIRIES

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ABSTRACT

Man's use of water is necessary for economic and social well being and, for the perpetuation of life itself. However, the indiscriminate use of this resource is a primary reason why the quality of water is vulnerable to degradation. The western provinces are endowed with exceptionally good quality water in the Canadian Shield and mountainous regions but have generally poorer quality water in the agricultural, drought-prone, and more populated areas of the prairies. The water quality issues of the future will be a manifestation of how man uses water both today and tomorrow in the development of water supplies for rural and urban uses, industry, and agriculture. Issues will include eutrophication, toxic chemical contamination, salinization as well as a decline in aquatic quality and the life systems it supports. Protection and enhancement of urban and rural drinking water quality will receive the highest attention. Ground waters will be further exploited giving rise to

greater potential for aquifer contamination. Water is a scarce commodity in some areas of the prairies and, as such, water use conflicts, integrated basin management, and the balancing of economic growth with environmental quality constitute a major challenge for the future.

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INTRODUCTION

Water quality has gone from a topic of passive awareness to one receiving concentrated attention throughout Canada and in all other corners of the globe (Pearce et al, 1985). A water quality issue essentially arises when a use of that water is at risk or has been limited because of its quality.

Poorer water quality is as much a value judgement as it is a condition which limits the use of that water. For example, to you and I as recreational enthusiasts, our judgement that Pasqua Lake is not the best lake for swimming in, is a manifestation of our perceptions of the water which may contain weeds, offensive odours and color and be highly turbid. To the scientist, poor water quality is much more; it is a complex phenomena characterized generally by the unhealthy life forms it supports and specifically by undesirable chemical, physical and biological properties. To industry, poor water quality can result in high treatment costs, equipment failure and poor products, less dilution capacity and lower tolerance for waste assimilation.

Whether good or bad, whether assessed by you, I or industry, the quality of water is determined on the basis of its suitability for use by man and other life forms.

This presentation will focus on the primary water uses (Table 1.0) which we wish protected or enhanced and the water quality concerns associated with each of these. In conclusion, I will highlight the specific water quality issues I perceive as being of future concern.

Prior to about 1940, water quality issues were mainly related to bacteriological and disease contamination of drinking water supplies. The growth in industry during the war resulted in advances in treatment technology beneficial to both industry and other water users. Advances in science increased our awareness of conventional pollution and pollution of a more subtle and insidious form, that is, toxic chemicals and their long-term effects on man and the environment. Today, water quality issues are exponentially more complex, diverse and of greater concern than ever before. We continue to make advances in handling municipal wastes and providing good drinking water. Nevertheless, these issues continue to prevail and are now further complicated by the chemical age and man's reliance on pesticides and other toxic chemicals.

DRINKING WATER

As knowledge of toxic substances in the environment grows, so does our concern for the quality of drinking water. In a region where a large variety of pesticides are used, drinking water sources are bound to be susceptible to contamination. Toxic substances exist at such low concentrations that the concern is seldom acute toxicity, whereas chronic

TABLE 1.0 PRIMARY USES OF WATER IN THE PRAIRIE PROVINCES

Drinking Water

Domestic Applications

Aquatic Life

Wildlife

Recreation

Industry - Forestry, Mining, Food Processing . . .

Energy - Fossil Fuels, Nuclear, Hydro

Agricultural - Crops, Livestock

toxicity, carcinogenicity and mutagenicity are frequently of concern today. It is not only the parent compounds and the active ingredients that cause risks. There are the impurities, breakdown products, metabolites and the combination of substances which complicate matters (Gummer, 1981). Testing may show that any single pesticide or its breakdown products are innocuous. But can this be said of the same substance which may combine with other substances occurring naturally or synthetically in the environment? We have information which reveals that many commonly used pesticides occur at low concentrations for long periods of time (Gummer, 1979). How long can man be exposed to such low levels without being harmed? An example is the presence of 2,4-D. There is no information on the effect of long-term exposure to 2,4-D levels in the 100 parts per trillion range often observed in our regional waters. As if to further complicate matters, our pesticide monitoring and analytical technology is as rapidly outdated as our list of pesticides being used. It is thought that some pesticides may be hazardous to human health and aquatic life at concentrations lower than the concentration that can be reliably detected with our conventional methods (Gilliom, 1984).

Indicators of drinking water quality will continue to be dominated by controversial toxic chemicals over the next few years -- metals, industrial chemicals, trihallomethanes formed in the water treatment process and synthetic organic compounds, dioxin, chlorophenols, synthetic pyrethroids and other exotic insecticides, herbicides, and various

poisons which make up the group commonly referred to as pesticides. In this region where the population is spread throughout the agricultural areas, one has to be concerned about the quality of water that farmers are using. Small community supplies, dugouts and wells are also susceptible to contamination -- perhaps more so since they are located where pesticides are intensely used. Although the focus of attention will certainly be on supplies which serve large populations, I suspect that there will be a broadening of emphasis to include rural sites.

Dependency on ground water supplies raises water quality concerns related to the land use activities located above them. Nitrate concentrations above ten parts per million may result in the disease methemoglobinemia. Occurrences of this disease in Canada are indeed rare but the potential for increased incidences increases with increasing concentrations of nitrate in drinking water.

In the agricultural and other developed areas of the prairies, there is reason to be concerned about the effects of irrigation, dry land farming, fertilizers, handling of livestock wastes, and to a lesser extent, land disposal of wastes and industrial wastes on the concentration of nitrate in shallow aquifers. These concerns have surfaced in the United States where in Iowa, there has been a steady increase in nitrate levels in wells less than about 35 metres in depth. Speculation is that the increasing trend will continue as agricultural activities increase and irrigation practices expand. The same situation may apply to western Canada.

There will be continued concern about the contamination of water supplies by bacteria and viruses (Pearse et al., 1985), the benefits and disbenefits of chlorination, the resistance of viruses to treatment processes and the location of pollution sources near water supplies. Chlorine is still the best all-round disinfectant but its use in organic-rich waters is associated with the production of organochlorine compounds, some of which, such as chloroform of the group of the trihallomethanes, are suspected carcinogens. Southern prairie rural water supplies which do not originate with ground water tend to be highly organic in nature.

Bacteria are controlled by chlorination but are viruses? There is evidence that chlorination does not control all viruses and that viral and parasitic infections are still transmitted through drinking water. Smaller community water supplies which have a typically low contact time for chlorination probably run the highest risk of viruses getting through the system (Alberta Environment, 1983 Krenkel, 1980). For example, the parasite which caused the "Beaver Fever" scare in Banff in 1981-82 was Giardiasis Lamblia which cannot be controlled by typical chlorination practices -- an observation which hikers should be aware of when they select their source and treatment of drinking water in the back country.

Bacterialogical quality of water supplies is generally acceptable across the west. Some local problems may occur because of livestock operations and contamination from municipal/domestic wastes. A problem of potential

future concern relates to the use of small household in-line filters to combat taste and odour. Manufacturer's filter replacement instructions must be adhered to closely to prevent bacterial growth on the filters and their subsequent "break through".

About the raw water sources themselves, I expect that greater attention will be given to protecting these sources from contamination through the application of progressive water management strategies. Management will have to extend to those applications which create a risk to shallow ground waters used for drinking. Due to the need for more water for agriculture and other high water uses, reservoirs and water enhancement through diversions are potential future considerations for southern Saskatchewan and Alberta. One can speculate that one of the benefits of such projects will be improved drinking water supplies.

I couldn't complete my comments on drinking water quality without mention of taste and odour problems which typify many of our prairie water supplies. Having experienced the Regina, Saskatchewan situation and seen how the granulated activated carbon has removed these characteristics, points out the need to consider the application of this technology elsewhere in the west. There is a need for economical treatment systems for smaller communities and farms. Eutrophication of many regional water supplies, the state of organically rich and biologically active waters, is the primary reason why taste and odour problems are so prominent in western Canada. Future focus will be on upgrading and maintaining water

distribution systems, finding alternate water sources. Reclamation technology, and treatment technology to control such undesirable characteristics.

DOMESTIC APPLICATIONS

I have purposely separated the domestic use of water from the drinking water use because of the dual nature of the water quality issues associated with this use. First, domestic use requires suitable water quality to permit laundrying, bathing, cooking and other domestic activities. In some areas, these uses will suffer negative effects attributable to increase salinity and hardness. Secondly, this use in itself promotes water quality problems because of sewage wastes and the indiscriminant use of yard pesticides which reach our streams and lakes through urban runoff. Also, what happens to the other domestic wastes such as spent oil, fertilizers and expired pesticides? I believe that the significance of domestic contributions (urban runoff) to the loading of toxics into the environment is underestimated. I see evidence of indiscriminant pesticide use frequently during the summer which would lend support to this view.

Is the treatment and handling of municipal wastes, including sludges, commensurate with the degree of protection needed for water quality? Sewage wastes contribute to the degradation of water quality in reservoirs, lakes, and rivers by adding metals, organic wastes,

phosphorous, suspended solids, and bacteria. Conventional sewage treatment handling systems also include storm water and industrial wastes. Future focus will certainly be on tertiary treatment for large municipal systems, similar to those currently in operation in Calgary and Regina. In many centres, the municipal infrastructures is in serious need of repair (Pearse et al., 1985). As a consequence, governments at all levels will be considering the effectiveness of aging distribution lines, and working towards upgrading and applying preventative maintenance as may be necessary to further combat municipal and industrial pollution.

Individually, the small communities throughout the prairies have very little effect on the quality of the receiving water. However, in combination, they can have as significant an effect as several large cities. Therefore, dealing with these pollution sources on a basin-wide basis and in the context of what other pollution sources exist, is fundamental to protecting water quality. Before tackling the collective effects of small communities, preventative pollution measures must be considered for the larger cities such as Edmonton, Saskatoon and Winnipeg. This will be a major issue because of the high cost of retrofitting and constructing new treatment facilities capable of an adequate level of treatment. In this day and age of fiscal restraint and tight budgets, expensive undertakings of this nature are difficult to approve. The value we place on preserving or enhancing water quality for future benefits should go a long way towards justifying the expenditures.

AQUATIC LIFE

Aquatic life has only in the last few years become widely accepted by water management agencies as a legitimate water use. Water quality standards and objectives are often established on the basis of protecting aquatic life, giving recognition to the value of ecosystem stability and quality. Degradation of aquatic quality can have perturbations which extend upwards through the food chain, ultimately affecting man. The alteration of species divesity or community structure can for example, result in the shift from desirable sport or comerical fish to less desirable and more pollution tollerant scavenging fish. The effect of such a change is immediately felt on water-based recreation and local economies. The application of protectionist strategies are costly in the short-term but are a sound investment for a healthy secure future in the long-run because the cost of clean-up in dollars and life terms can greatly exceed the cost of pollution control.

It could be said that aquatic life live off the avails of water which is both its habitat and essential food source. Degradation of water quality can therefore have immediate effects on the aquatic biota. For this reason, it is not surprising that water quality issues of today focus on this water use. In the southern regions, the aquatic life water quality issue is predominantly related to the shallow warm prairie lake dilemma -- high summer temperatures, nutrient enrichment, prolific plant growth, and frequent oxygen depletion. During the winter these lakes typically become anaerobic, without oxygen, resulting in fish kills.

How will the future unfold for aquatic life? I believe that the situation will get worse before it gets better except on a site specific basis. Until water quality management strategies are enacted on a basin-wide basis, considering the implications and interactions of all uses together, protection of water quality will continue to be fragmental and fall short of what is achievable. In my view, for example, agricultural practices need to be better integrated within a plan which provides for the protection and enhancement of water quality in the southern half of the Prairie Provinces. Towards this end, I believe that water quality management will include such concepts as buffer zones or corridors around sloughs, lakes, reservoirs, and along the side of streams. This would minimize the aquatic impacts attributable to cultivating, grazing, fertilizing, and spraying adjacent to water bodies. A greater degree of protection would then be afforded to fish habitat, spawning grounds and the food sources of aquatic life. Lake Diefenbaker should be a candidate for such progressive management strategies as significant benefits would occur not just to aquatic life but also to recreational, industrial and municipal water uses.

A very significant trend in the nature of pesticides has occurred over the last few years. We have seen the demise of persistent insecticides such as Dieldrin, Endrin, and more recently Lindane. The latter is still registered but its use is declining. No longer is food chain biomagnification the concern it once was, at least for currently used pesticides. Although removing persistent pesticides is an important step

towards protecting all forms of life, much more still has to be done. Pesticides today tend to break down rapidly, non-target concerns still exist, and because of the proliferation of so many different pesticides (eg. Triallate, Difenzoquat and Deltamethrin), many questions relevant to water quality prevail. What are the breakdown products and how do they act in the environment? What are the acute and chronic effects of the parent compounds and their breakdown products, singularily and in combination, which may impact on aquatic life, for example? What are the effects on aquatic communities related to the practice of using insecticides in the aquatic environment for controlling Blackfly and Mosquito populations?

There is, at this time, little alternative to using pesticides if the same level of agricultural productivity is to be maintained. Yes, there are organic farmers making a go of things without pesticides and I applaud them. But the international pressures and economic pressures of home are so high that to do so across the prairies at this time would be unthinkable. Biological control alternatives to the use of pesticides are being researched now at many universities across North America. It is my hope that the water quality implications of biological control will be considered in the context of the stability and integrity of aquatic ecosystems.

A secondary water quality issue relates to the organisms' responses to changes in quality and just what this means ultimately to man.

Fortunately, organisms provide man with an opportunity to catch a glimpse of what may eventually befall him if action is not taken to correct an environmental problem. Within the next three to five years we will have advances in science and technology which will allow us to observe how aquatic organisms are behaving in the water systems upon which we rely. This presumes that as the quality of water declines, there will be a coinciding perturbation or effect observed in some biotic species which in turn triggers an alarm, warning man of undesirable water quality.

Acid rain and its known impacts on the environment in Canada is largely an eastern phenomena. However, this must not result in complacency on the part of western industry and governments. The Rocky Mountains of Alberta and the Canadian Shield portion of Manitoba and Saskatchewan have the best western recreational areas and generally unadulterated aquatic ecosystems. On the Canadian Shield are found some of the more sensitive waterbodies of these provinces. The mineralization of these areas, the hydro potential, and large natural reservoirs of fresh clean water will result in future exploitation of considerable magnitude. As secondary industry develops around mining and petroleum, there will be greater potential for atmospheric loading of acid inducing compounds such as sulphur and nitrogen. We must act now to ensure that development proceeds in an environmentally compatible way to avert environmental acid rain disasters experienced elsewhere. Towards this end, Manitoba has adopted atmospheric target load regulations for sulphur dioxide.

WILDLIFE

The delcine of migratory bird populations is largely attributable to agricultural exploitation of good nesting habitat and hunting pressures. The impact of pesticides and other contaminants on breeding is a current issue. What effect does repeated pesticide use have on the biological quality of water, in other words, the food sources of waterfowl and other wildlife? As waterfowl are compressed into shrinking wetlands by urban sprawl and agriculture with its arsenal of insecticides and herbicides, disease and poisoning can do deadly work among geese and ducks (National Geographic, November 1984). Degraded water quality can result in the alteration or loss of Phytoplankton, Zooplankton, Invertebrates, and other organisms which in turn can have direct impact on migratory birds. Botulism outbreaks in Southern Saskatchewan are aggravated by man's interference with nature and changes in water quality.

How does the future look as regards the transfer of disease to waterfowl through deteriorated water quality? Consider the "troubled waters" at Kesterson National Wildlife Refuge near Gustine, California. There, in 1983, were found deformities and a high mortality rate in newborn and embryonic Coots, Grebes, and ducks (U.S. Geological Survey, 1984). Agricultural drainage containing high concentrations of selenium, resulting from irrigation return flows, is believed responsible. Selenium is an essential nutrient for man and animals at concentrations of about 0.040 parts per million. At concentrations above 4.0 parts per

million, that is two orders of magnitude higher, selenium can become toxic to animals. Some drains in the bordering irrigation district near Kesterson contained selenium as high as 4.2 parts per million. The minimum limit established by the U.S. Environmental Protection Agency for classification of dissolved selenium as a hazardous waste has been set at 1.0 part per million. In drinking water, the criterion is 0.01 parts per million (Health and Welfare Canada, 1978). Surface waters in Western Canada typically have concentrations below the analytical detection limit of 0.0005 parts per million (Water Quality Branch, 1985, D. J. Forsyth, 1986). One river system , the Oldman River does stand out uniquely different from most western rivers with selenium concentrations frequently (67% of time) above the analytical detection limits but at a level not exceeding 0.0014 parts per million. The potential of a future selenium water qualtiy issue in seleniferous areas of Alberta and Saskatchewan is currently being considered by the Canadian Wildlife Service (G. Shaw, 1986, Personal Communication). As Forsyth (1985) reports, the potential issue is not so much the Oldman River quality as it is selenium which may precipitate in reservoirs to form sinks in the sediments. Furthermore, it would be of concern if irrigation drainage of high selenium content flowed into wetlands used by waterfowl.

It has been reported in recent years that acid rain can be both directly and indirectly damaging to wildlife. Acidfield lakes reduce or eliminate life forms in the water. When this occurs, survival of the fittest certainly still exists, but no food -- no survival. The concern also

extends to heavy metal contamination. The Canadian wildlife service of Environment Canada says that the potential for contamination of wildlife by heavy metals mobilized by acid rain may be high (Environmental Conservation Service, 1985). In Western Canada, acid rain is not an issue except in the immediate vicinity of industrial pollution sources such as at Thompson, Manitoba, and in the future, possibly the oil sands area of Alberta. As mentioned earlier, economic pressures could result in new secondary industries associated with mining and energy, and the concomitant increase in water quality problems in northern areas.

RECREATION

The need for leisure time and recreation to offset the stress and strain of urban life has to a significant extent resulted in increased use of water. Water sports have been rated as the most enjoyable of outdoor activities (Environment Canada, 1984). With this has come a greater public demand for protection of the environment for its enjoyment and a demand for improved water quality, particularly of lakes and reservoirs used for contact sport. This is true universally and is evident in western Canada, where in the populated areas of Saskatchewan, there are a few good quality water bodies. In Southern Saskatchewan, Lake Diefenbaker presents the only major good quality recreational resource. Increasing use is inevitable, hence it deserves progressive protectionist water quality management strategies as do the still yet largely, unadulterated northern water bodies of the Prairie Provinces.

Future focus of water management agencies will inevitably swing to reclaiming apparently written off water bodies. This will require new and innovative technology to reverse, or at least retard, eutrophication of reservoirs and lakes. One can expect that diversions of good quality water, from such areas so blessed, will be in part justified on the basis of recreational use.

Agriculture, municipal and industrial wastes combine to present a collective problem of euthrophication which is very costly and difficult to combat. These same pollution sources can result in bacteriological pollution and the closure of beaches. According to the Canadian Council of Resource and Environment Ministers (1984), this is a high-profile public and media matter because most of the beaches are in highly populated areas where the demand for recreational sites is high. The federal/provincial Qu'Appelle Valley implementation plan established under the Canada Water Act, has resulted in the abatement of the major pollution sources. Much remains to be done, however, in the area of controlling nonpoint source pollution and lake restoration before significant quality improvements will be realized in the fishing lakes. The warming of waters, continued anthropogenic sediment loadings, nutrient enrichment, and toxic contamination will perpetuate and create problems regarding swimmer's itch, fish kills, infestations by weeds, noxious biological growths, unacceptable to both eye and nose, and the overall quality of the recreational resources.

INDUSTRY

Saskatchewan, Alberta, and Manitoba are "blessed" with a lack of industrial development, at least insofar as having to deal with industrial pollution. It is this very lack of development which makes industrial growth a prime target of economic pursuit. When we speak of industry today what comes to mind in the context of pollution in industrial waste, toxic chemicals, and acid rain? There are other water quality concerns associated with such industries as forestry, mining of fossil fuels and minerals, food processing, and agriculture itself. Water quality issues related to how these industries conduct their business and handle their wastes include:

- Deep well injection of wastes and implications to ground water systems;

- Effluent irrigation and the contamination of soils such eventual contamination of surface and ground waters;

- Solid wastes and sedimentation in reservoirs and creation of toxic sinks;

- Nutrient loading and eutrophication and secondary water quality and water use problems:

- Organic load and the depletion of oxygen reserves in lakes and rivers;

- Landfill and waste dump seepage to ground and surface waters;

- Diversion and other alterations to aquatic regimes which may affect ecosystem tolerances.

With better than 30 percent of Saskatchewan located on the Canadian Shield, the potential for increased mining is considerable. Mining can expect to increase in Saskatchewan, markets willings, particularly with respect to gold and base metals. The state of water quality during production and following decommissioning will be a major factor to be dealt with in the future. Careful consideration must be given to the ecosystem's ability to assimilate wastes and to recover from waste inputs and physical alterations of the hydrologic regimes.

Experience has shown that once in the environment, mercury and other metals released through tailings wastes can cause social and economic impacts of considerable magnitude. Therefore, environmental quality guidelines are necessary for wise development of northern resources.

Management of industrial wastes is a growing national concern. Neutralizing of wastes, other chemical treatments, deep well disposal, and incineration all have associated water quality considerations. Deep

well disposal provides a new alternative for controlling wastes. Can we be certain that the bedrock or other geologic formations into which the storage caverns are drilled do not now, or in the future have connections to aquifers thereby rendering them susceptible to contamination? Are we adopting a management approach similar to a philosophy of "the higher the smoke stack, the smaller the problem"? We now know that taller stacks made air pollution less perceptible at the industrial site and spread the contamination over very large areas remote from the source. Areas previously believed unadulterated by man are now victims of long-range transport of air pollution. Deep well injection in the short-term may be an "out of sight, out of mind" alternative. Could it be that in time we will learn that the major underlying aquifers have been contaminated not just on a local basis but on a regional or interjurisdictional basis? The consequences of contaminating an aquifer are large; consider, for example, trying to decontaminate an underground system.

The reality of the waste handling situation is that man must find alternatives to discharging directly into the aquatic environment or more effective treatment processes. Dilution of effluents with receiving waters has been shown to be an unacceptable control of toxic substances which can accumulate in sediment and biological sinks and then be transferred through the food web. The degree to which a stream can tolerate waste, or its assimilative capacity, is an elusive characteristic, again, with respect to toxic substances. The risks and hazards of the alternatives must be carefully weighed and perhaps the

price we pay for economic and social values is some deterioration of water quality with whatever approach is selected. It can be anticipated that there will be water quality concerns related to deep well disposal (which may be the best of several evils) for handling municipal and industrial wastes (Table 2.0).

ENERGY

The development and supply of electricity requires a considerable amount of water whether it is for the direct production of power or whether it is for cooling and steam generation as in coal-fired power plants. Underlying much of Southern Saskatchewan, from the Cypress Hills to the Souris River Valley, are exploitable beds of coal. With it development will come the classical water quality concerns regarding total dissolved solids, boron, heavy metals, and radionuclides. Dewatering of the coal beds will result in elevating the concentrations of some salts and perhaps metals in the receiving water environments. As evidenced thus far in the Poplar River Basin, this form of pollution has not reached levels of major concern. However, a watchful eye will need to be kept on the coal operations, particularly with respect to ground water contamination from ash lagoon seepage should it occur to any significant extent. The fallout from coal-fired power plants in Alberta and Saskatchewan has not yet created any significant water quality issues. A primary water quality concern aside from those noted above is the thermal discharge which can alter the receiving water body ecosystem and promote

eutrophication. This has been more of a concern in Alberta at Lake Wabamum than it has been anywhere in Saskatchewan.

Nuclear energy has not been developed in Saskatchewan although there is potential for small community reactors in remote locations. However, their implications to water quality are thought to be virtually nonexistent.

AGRICULTURE

There are several agricultural activities which have potential impacts on both surface and ground waters. These include irrigation, livestock and poultry operations, fertilizing, dryland farming, approaches to soil management, and pesticide application. I will not elaborate any further on the specific concerns related to drinking water.

Agriculture generally results in nonpoint source pollution which is very difficult to quantify. Evidence, However, is mounting to suggest that the control of thes sources is significant in our quest to combat the nutrient, pesticide, and salt contamination of our streams, lakes, and reservoirs. Even without man's influence, many of the lakes in Saskatchewan have limited recreational capacity due to naturally occurring eutrophication processes. However, cultural eutrophication, the nutrient enrichment caused by man has aggravated the situation

(Canadian Council of Resource and Environment Ministers, 1985). For example, the fishing lakes are in advanced stages of eutrophication, and as well, are within a high recreational use area of Saskatchewan.

I project that we will have to deal more intensely with water quality problems tied directly to agricultural practices. The contemporary problem with pesticides will not go away but will become a greater issue as regards the quality of both urban and rural drinking water.

Irrigation growth in southwestern and central Saskatchewan will give rise to potential return flow potential return flow problems for ground water and surface waters, touching upon such aspects as increases in total dissolved solids, nitrates, pesticides, ecosystem health, phosphorous and sediment borne contaminants with the net result that downstream water uses may be impacted.

Associates with improving water supply to drought-prone areas is the construction of reservoirs and possibly the diversion of rivers of one basin into another. It is widely known that newly formed reservoirs can result in the mobilization of mercury from inundated sediments through microbial action. This results in restrictions on sport and possibly commercial fishing when body burden levels exceed the Canadian standard of 0.5 parts per million. This occurred in Cookson Reservoir of the Poplar River Basin, Southern Indian Lake of Northern Manitoba, and quite possibly Tobin Lake. Although in the latter case, it would be impossible

to separate the effects of the past discharges from upstream chloralkali plants. With diversions, we run risk of transferring parasites and foreign biota that could greatly alter the recipient waterbody's ecosystem. These factors will be issues which will need to be dealt with to alleviate public concern and to prevent irreversible environmental damage.

In the environmental field, salinity is almost an unrecognized water quality issue with the exception of its impact on sensitive crops. There is every reason to believe as irrigation spreads across Southern Alberta, Saskatchewan and Manitoba, there will be increased salinization of shallow aquifers and surface waters. Increased salinity may alter aquatic communities, foul drinking water supplies and increased water treatment costs for industry and municipalities. The pros and cons of irrigation versus other desirable water uses of perhaps equal or better economic value and environmental compatibility, need to be understood before embarking on massive irrigation projects. Canada and Saskatchewan have recently developed a study plan and agreement, subject to the approval of both governments, to undertake a cooperative water management study of the South Saskatchewan River Basin. Inherent within the potential study is the reconciliation of existing water quality with the water uses of today and tomorrow. Irrigation opportunities will figure prominantly in the water planning study as will the concern for salinization and eutrophication of waters.

Flow regulation and water withdrawl can have profound impacts on water quality. Consider for example the irrigation practices in Southern Saskatchewan River Basin. Irrigation is a high consumptive water user. The Prairie Provinces Water Board reports (PPWB, 1983) that during the period 1951 to 1978, inclusive, 87 percent of the water consumed in the Saskatchewan-Nelson River Basin was attributed to agriculture. Of this amount, 75-90 percent was on account of irrigation. Therefore, potential conflicts could arise in the future with those users which also require water for dilution or sustaining purposes. Man-made water storage areas can reduce the cleansing phenomenon (in downstream areas) associated with the spring runoff period and higher instream flows. While on the other hand, storage if regulated to maintain optimal flow conditions during otherwise no-flow situations, can be used to enhance quality conditions. The future will need to consider the balancing of storage for irrigation and other uses with the maintenance of a satisfactory level of instream water quality.

The effect of livestock operations on the quality of both ground and surface waters depends on the size of individual operations, the collective size, their proximity to surface waters, the drainage and the manner of operation. It is interesting to note that one cow's daily output is approximately equal to that of six humans. All we need is 30,000 cows to, in effect, equal the sewage output for the city of Saskatoon! I wonder how many big cities we have out there? Considerable

progress has been made within the Qu'Appelle River Basin regarding the relocation of those operations bordering too close to the Qu'Appelle River or its main tributaries. Livestock operations nevertheless continue to be, in my view, an agricultural activity which requires closer evaluation and improved control to limit their impact on receiving waters. Drinking water from well supplies located in shallow aquifers are vulnerable to contamination from livestock operations and as such is a concern in Western Canada. As concern for the quality of water used by rural populations grows, so will our knowledge of the extent of aquifer pollution that already exists.

POTENTIAL GEOGRAPHIC AREAS OF WATER-USE CONFLICTS

Virtually all water bodies have some water quality issue of concern. Those areas in the prairie provinces which have the major concerns and the greatest potential to result in interjurisdictional and inter-use conflicts are mentioned below on a river basin basis, as are some of the water quality issues:

HUDSON BAY DRAINAGE

RED RIVER BASIN:

Municipal wastes from Winnipeg; pesticide runoff from agricultural practices; industrial wastes from Winnipeg; international focus:

pollution loadings from the United States; chlorination, bacteriology, eutrophication; quality of Assiniboine River; urban runoff; quality of aquifers and surface waters for urban drinking water purposes; waterfowl and the Red River Delta quality; recreational water quality of the Red River; fish contamination; aquifer contamination;

SOURIS RIVER BASIN:

Municipal and other discharges from the United States including J. Clarke Salyer Wildlife Refuge and Irrigation Flows; dissolved oxygen levels and fish kills; taste and odour; quality of source water for the Town of Souris, Manitoba; livestock operations in the Souris River valley and in Pipestone Creek; eutrophication of impoundments; and small lakes such as Kenosee; pesticides and salinity; proposed Alameda and Rafferty Reservoirs in Saskatchewan; aquifer quality; power generation and coal mining; water importation; quality of rural drinking water supplies; sustained flow during winter and late summer periods; international and interprovincial focus;

ASSINIBOINE RIVER BASIN:

Municipal and industrial wastes from Winnipeg, Brandon, Portage La Prairie, and smaller municipalities; deep well treatment systems and waste handling; agricultural runoff quality-sediment, pesticides and nutrients; quality of rural aquifer and surface water supplies for

drinking water purposes; Qu'Appelle River water quality; sustained flow and flow regulation;

LAKES WINNIPEG, WINNIPEGOSIS, AND MANITOBA:

AGRICULTURAL RUNOFF CONTAINING NUTRIENTS AND PESTICIDES:

Agricultural runoff containing nutrients and pesticides; eutrophication; discharges from municipal and industrial developments; irrigation return flows; diversions and foreign biota; lake levels regulation; sedimentation and sediment quality; toxic sinks; mercury and other toxics in sports and commercial fish; support of large waterfowl populations; interprovincial water management;

WINNIPEG RIVER BASIN:

Mercury from English-Wabigoon River systems; pulp and paper industrial discharges; radionuclides and aquifer quality; mining developments; interprovincial water management;

QU'APPELLE RIVER BASIN:

Point and non-point agricultural runoff and its pesticide, nutrient and salinity quality; livestock operations; eutrophication of fishing lakes; recreational water quality; fisheries-mercury, pesticides and dissolved

oxygen; waterfowl; potash industry; deep well injection of wastes; municipal discharges from Regina and Moose Jaw; effluent irrigation; river and lake regulation; aquifer quality; urban and rural drinking water quality; Moose Jaw Creek sediment and water quality; interprovincial;

NELSON RIVER BASIN:

Power generation, flow regulation and Churchill River diversion; erosion; ecosystem stability; quality of water to northern communities; mercury mobilizaton in regulated lakes and fisheries implications; limestone and other new generation plants; treatment of community wastes;

CHURCHILL RIVER BASIN:

Mercury mobilization in southern Indian Lake and impacts on fisheries and human health; quality of drinking water to northern communities; treatment of community wastes; power generation and effects on quality; acid rain near Thompson and Flin Flon and from future developments in Alberta; uranium and mining of other metals in Saskatchewan and Manitoba; diversions and effects on fisheries and other aquatic life; petroleum developments in Beaver River basin at Cold Lake, Alberta; deep well disposal of uranium and other mining, and petroleum wastes; recreational water quality; interprovincial;

SASKATCHEWAN RIVER BASIN:

Agricultural runoff and its pesticide and nutrient quality; municipal and industrial wastes; toxic sink in Tobin Lake; quality of Tobin and Codette Reservoir; hydo power and flow regulations; recreational water quality; quality of aquatic ecosystem in the Saskatchewn River delta, and waterfowl; interprovincial;

SOUTH SASKATCHEWAN RIVER BASIN:

Point and non-point agricultural runoff and its pesticide, salinity and nutrient quality; irrigation in Southwestern Saskatchewan and Southern Alberta; eutrophication of Lake Diefenbaker; recreational water quality; wetland quality and waterfowl; urban and rural water supplies; mercury below Saskatoon; toxic sinks in Lake Diefenbaker; diversion of South Saskatchewan River to drought prone areas of Southern Saskatchewan River; reservoirs for water storage to supply irrigation and other water uses, as on the Red Deer and Oldman Rivers; municipal discharges and spills from Saskatoon, Calgary etc.; industrial waste discharges; drought effects on quality; fisheries below Calgary and in particular, in Lake Diefenbaker; quality of water below Banff townsite and other park facilities; back country water quality; Red Deer Water quality below Red Deer and Drumheller cities; blackfly and mosquito control; interprovincial;

NORTH SASKATHCHEWAN RIVER BASIN:

Agricultural runoff and its pesticide and nutrient quality; nutrient and toxic wastes from Edmonton and chemical plants; recreational quality below Edmonton and Prince Albert; pulp and paper industrial wastes-organic and toxic; coal and petroleum developments; fish quality-metals and pesticides; spraying of insecticides for controlling black flies; status of aquatic life in fluvial and lacrustrine systems; water diversions and flow regulation effects on quality; interprovincial;

ARCTIC DRAINAGE

ATHABASCA RIVER BASIN:

Mining and petroleum wastes, phenol and metal contamination of fish in lower Athabasca River; acid rain emissions; pulp and paper wastes-organic loads, toxic substances and particulate matter in upper Athabasca and Peace rivers; clear cutting and forestation practices; coal mining in the McLeod River drainage; recreational water quality; back country and Jasper Park, water quality; hydro development; quality of aquatic ecosystems; interprovincial and provincial-territorial;

GULF OF MEXICO DRAINAGE

MILK RIVER BASIN:

Flow regulation-dams, reservoirs; mercury mobilization; eutrophication; irrigation; international obligation;

FRENCHMAN RIVER BASIN

Irrigation; variable flows; pesticides; sports fisheries; aquatic quality-dissolved oxygen; nutrients; aturally occurring radionuclides; international obligations;

POPLAR RIVER BASIN:

Coal mining and dewatering; thermal wastes; aquifer quality-metals and radionuclides; mercury in fish; nutrient enrichment; international obligations; coal-fired plant waste-ash lagoon seepage; argricultural runoff; future water diversions;

CONCLUSION

A common theme throughout my presentation has been the need to consider the implications of pesticide use, industrial discharges, river diversions, and other factors which affect water quality, not only

individually but also in combination. Water quality at any point in a river basin is primarily a reflection of all activities, both natural and anthropogenic, which are located upstream. This is precisely why I strongly advocate that management be undertaken on a basin unit concept with due regard to protecting and enhancing water quality for beneficial water uses and reconciling conflicts between water uses. The question of whether waste discharge is a justifiable use of receiving waters needs to be dealt with on the basis of economic and social benefits but balanced with the potential impacts on water quality.

Tomorrow's issues are going to be for the most part an extension of what prevails now; or, a result of what man is now doing within the environment. In my opinion, the future water quality issues which we will have to pay particular attention to are:

1) Eutrophication

   Its effect on drinking water; preventative, restorative action; control for recreational and fisheries benefits.

2) Toxic Substances

   Pesticides and their presence/abundance in ground and surface waters, aquatic biota and drinking water; effects of pesticides on ecosystem stability; toxins formed during the chlorination process; rural as

well as urban water supply quality; selenium trends in irrigation districts and effects on biota.

3) Water Borne Diseases

Bacteria, parasites and viruses particularly in rural water supplies; effectiveness of small treatment systems to control diseases.

4) Salinization

Irrigation return flows and impacts on aquatic life and municipal water supplies.

Due to economic pressures, water quality will need to be reckoned with as drought proofing is sought, irrigation practices expand, and water supply options are developed. Pressures are so great on the existing surface water supplies that ground water, particularly in the southern parts of the prairies, will need to be developed to meet new water use demands. The quality of this resource in addition to the quantity will determine its economic value.

The tone of this presentation by virture of the title "Future Water Quality Issues In The Prairies", has been negative. Seldom are "issues" a positive consideration. I'd like to conclude my presentation by stating that the prairie provinces are in a unique situation compared to

many industrialized provinces and countries and as such enjoy a comparatively natural environment notwithstanding the impacts discussed above. To sit back and be complacent is, however, not desirable. We must exercise prudent projective judgement in keeping our waters clean and undertaking action to restore those waters which have been adulterated. Progressive and active ongoing consideration of water quality is preventative medicine to avoid problems that could otherwise occur for future generations. It is in this spirit that I have attempted to discuss water quality issues of the prairies.

SELECTED REFERENCES

Alberta Environment, 1983. Environment Views, Water Quality, Vol. 6. No. 5, September/October.

Canadian Council of Resource and Environment Ministers, 1985. Canadian Water Quality Issues, prepared by the CCREM Task Force on Water Quality Guidelines.

Deveral, Steven J., 1984. In United States Geological Survey, National Water Summary 1984, Water Supply Paper 2275.

Environment Canada, 1984. Only on Earth.

Forsyth, D.J., 1986. (In Preparation) Selenium in Surface and Ground Waters in the Prairie Provinces.

Gilliom, Robert J., 1984. In United States Geological Survey, National Water Summary 1984, Water Supply Paper 2275.

Gummer, William D., 1979. Pesticide Monitoring in the Prairies of Western Canada, Water Quality Interpretive Report No. 4, Environment Canada.

Gummer, William D., 1981. Pesticide Issues and Environmental Concerns, Presented At Farm Forum, February 26, 1981.

Krenkel, Peter A. and Vladimir Novotny, 1980. Water Quality Management, Academic Press, New York.

National Geographic, 1984. American Waterfowl: Troubles and Triumphs, Vol. 166, No. 5.

National Health and Welfare, 19XX. Canadian Drinking Water Guidelines.

Prairie Provinces Water Board, 1983. Historical and Current Water Use in the Saskatchewan-Nelson Basin, Report No. 70.

U.S. Protection Agency, 1980. Hazardous Waste Management System: Federal Register, Vol. 45; No. 98.

Water Quality Branch, Environment Canada, 1985. Detailed Surface Water Quality Data, Alberta, Manitoba, Northwest Territories and Saskatchewan, 1982.